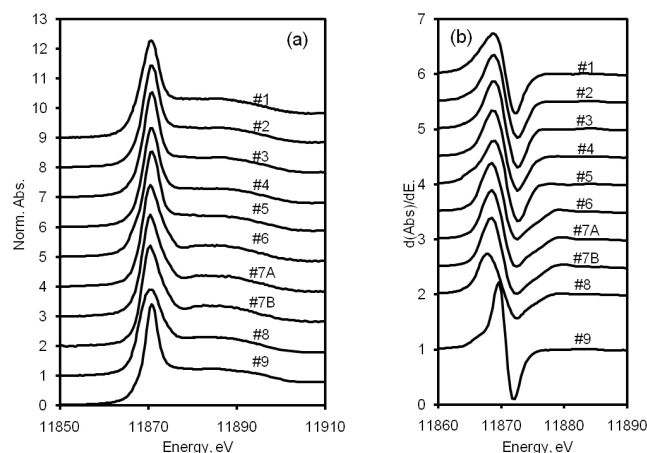


Featured Highlight

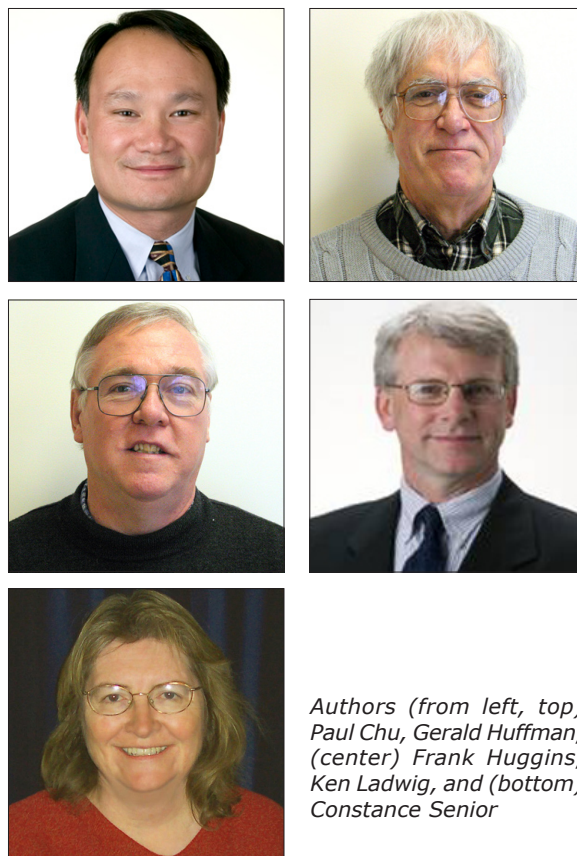
Investigating Arsenic and Selenium in Fly Ash From Coal Plants

Arsenic and selenium – two of the most volatile and potentially hazardous elements to be released from commercial coal-burning plants – are also found in large quantities in the byproduct of the electricity-producing process. This fine residue, known as fly ash, is produced in large quantities as coal is burned and can either be used in “green” applications such as concrete, or disposed of in landfills and tailings ponds. To learn more about how these potentially toxic elements are released when submerged in water, a team of researchers used the NSLS to determine the basic characteristics of selenium and arsenic in fly ash samples collected from several plants in the United States and Canada.

“A huge amount of electricity is generated from coal, which means huge amounts of coal combustion and waste materials,” said University of Kentucky researcher Frank Huggins. “About 10-20 percent of the mass of the coal comes out as fly ash, and there are some uses for the material, but most of it ends up in ponds. Ultimately, we want to find out how much of these trace elements leach out and how far they go.”



Arsenic XANES (a) and derivative XANES (b) spectra for 10 fly-ash samples from full-scale pulverized coal combustion plants in North America. Samples 1 - 5 and 9 were derived from plants burning eastern U.S. bituminous coals that are rich in sulfur and iron. In contrast, samples 6 – 8 were derived from plants burning western subbituminous coals that are low in sulfur and rich in calcium. The spectra show that the arsenic is present in the fly-ash principally as arsenate species. Also, the XANES spectra for arsenic, as well as for selenium (not shown), exhibit systematic differences that reflect the type of coal. The spectrum for sample #9 was collected using a Si(220) monochromator crystal set and exhibits noticeably better resolution than the other nine spectra, which were collected using a Si(111) monochromator crystal set.



Authors (from left, top)
Paul Chu, Gerald Huffman,
(center) Frank Huggins,
Ken Ladwig, and (bottom)
Constance Senior

Using x-ray adsorption fine structure spectroscopy (XAFS) at NSLS beamline X18B and at the Stanford Synchrotron Radiation Laboratory, Huggins and his team of researchers determined the oxidation states and speciation of selenium and arsenic in samples from coal-fired utility plants burning a range of coals. These factors primarily determine the elements’ toxicity and how easily they escape from the material, Huggins said.

“Generally, the higher the oxidation state of the element, the more soluble it is, and the easier it gets into the water supplies,” he said.

After examining 10 samples of two types of coal – eastern United States bituminous (Fe-rich) and western North American sub-bituminous (Ca-rich) – the researchers discovered that selenium is found predominantly as Se(IV) and arsenic is found as As(V). Similar spectral details were observed for both arsenic and selenium in the two different types of fly ash, suggesting that a major component (possibly Fe in bituminous

coal or Ca in sub-bituminous coal) controls the capture of these elements by fly ash during combustion. The results were published in the May 1, 2007 issue of *Environmental Science & Technology*.

The XAFS work performed by the research team, which also includes Constance Senior (Reaction Engineering International, Salt Lake City, Utah), Gerald Huffman (University of Kentucky), and Paul Chu and Ken Ladwig (Electric Power Research Institute, Palo Alto, CA), is meant to complement another study on arsenic and selenium fly ash leachability.

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— Kendra Snyder